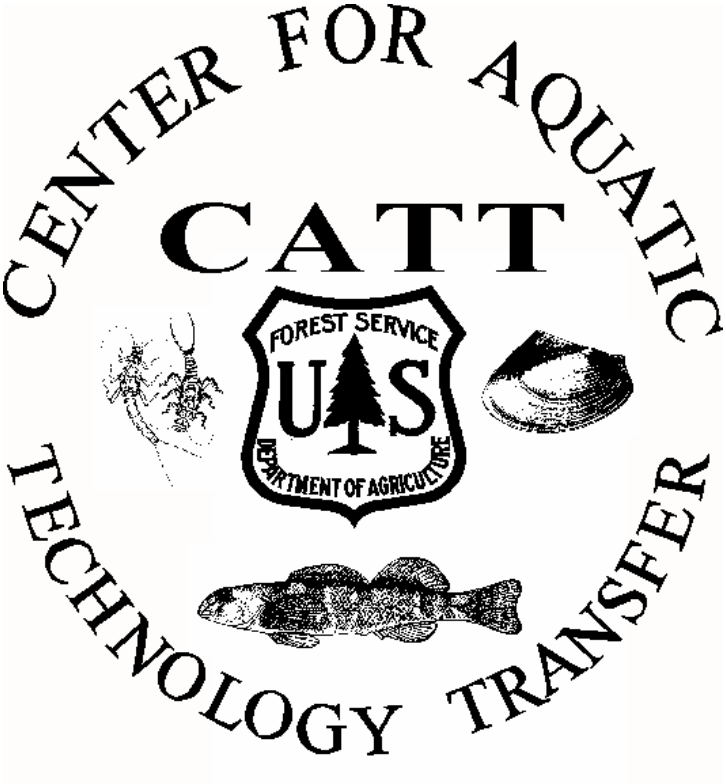
Summary of Stream Inventories on the Daniel Boone National Forest, 2005-2007



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USDA

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Introduction

Resource specialist from the Center for Aquatic Technology Transfer (CATT), Daniel Boone National Forest (DBNF), National Forest of North Carolina (NFNC), and George Washington Jefferson National Forest (GWJNF) and Regional Office (RO) met with scientist from the Southern Research Station (SRS) in March 2005 to develop a stream monitoring program. All parties acknowledged that existing monitoring programs (e.g. Hixson et al. 2004, Walker and Bishop 1991) were too intensive to sustain over the long term. Our goal was to develop a framework for a standardized, sustainable monitoring program for all National Forests in the Southern Region. The DBNF volunteered to test the new methodology and initiated a pilot monitoring program. CATT field crews performed inventories on the DBNF in 2005, 2006, and 2007. We deployed teams of biologists and technicians from June 7 to 17, 2005, July 18-27, 2006, and July 13 to 19, 2007 to quantify stream habitat conditions and provide associated fish assemblage information.

Methods

Reach Selection

The Environmental Protection Agency randomly selects sites within the DBNF (Olsen, 2005). From these sites, DBNF stream reaches had to meet the following criteria: 1) watershed greater than 13 km^2; 2) depth shallow enough for backpack electrofishing. If the average wetted width was less than or equal to 3.0 m or greater than or equal to 7.5 m the reach length was 120 m or 300 m, respectively (Appendix A). In all other cases sample reach length was 40 times the average wetted width. Average wetted width was calculated by taking width measurements in 1-2 riffles or runs within each reach. We did not move reaches to avoid road or trail crossings.

Macroinvertebrate Inventory

We collected macroinvertebrates at least one day prior to electrofishing to avoid possible biasing of the fish sample. Crews collected macroinvertebrates using riffle sample and multi-habitat sample methods described by Pratt (2002). See Appendix A for detailed field methods.

Pebble Count Inventory

Electrofishing crews also conducted pebble and bar counts in riffle habitat units to characterize the substrate composition of sample reaches. Crew members measured the intermediate axis of a minimum of 100 pebbles per riffle as described in Bunte and Abt (2001) and Kappesser (2002). See Appendix A for detailed field methods.

Habitat Inventory

Two-person crews performed abbreviated stream habitat inventories (Roghair and Nuckols, 2005) based on the basinwide visual estimation technique (BVET) (Dolloff et al. 1993). We recorded attributes for all habitat units contained wholly or partially within the sample reach. We subsampled at least 3 fast and 3 slow water units within each reach where possible. We measured or estimated the following attributes:

All Habitat Units	Sub-Sample of Habitat Units
Type of habitat	Bankfull channel width
Length and width	Channel gradient
Maximum and average depth	Water temperature
Riffle crest depth	Photographs
Dominant and subdominant substrate	GPS coordinates
Rosgen channel type (Rosgen, 1996)	
Percent fines	
Large wood counts	

In addition, we noted stream features including:

- Waterfalls
- Tributaries
- Side channels
- Braided channels
- Seeps (springs)
- Landslides
- Bridges
- Fords
- Dams
- Culverts

See Appendix A for detailed field methods.

Fish Inventory

A four-person crew using a DC backpack electrofisher collected fish assemblage information within the same section length of stream inventoried for habitat. Crews attempted to apply standard effort of approximately 1 sec/m^2 of electrofishing habitat. We recorded the following data:

- Species name
- Counts of adult, age-0, and voucher specimens
- Sample reach length, electrofishing time (sec), and voltage
- GPS coordinates of start and end location

See Appendix A for detailed field methods.

Results

The CATT and DBNF personnel completed habitat inventories on a total of 66 sites (16.7 km) between 2005-2007 (Table 1). We did not sample fish at 10 sites due to the potential presence of blackside dace, a federally threatened species. The data collected by the CATT can be used to describe stream condition on the DBNF and serve as a baseline for future comparisons. In addition, these data will be used to test the effectiveness of the new Southern Region stream monitoring program (Leftwitch 2007).

Data Availability

Summer 2005-2007 habitat, fish, and pebble data are ready for migration into the Natural Resource Information System Water Module Version 1.2.3 (NRIS). We formatted the data according to the Southern Region NRIS Water migration template and transferred it to Leigh McDougal, the Regional NRIS migration coordinator. As data are migrated into NRIS Water the CATT will coordinate development of custom query and reporting tools for the DBNF. In the interim, the CATT is available to assist with data analysis and report preparation. Jon Walker, DBNF Forest Hydrologist, received a copy of all data in electronic format.

Figure 1. Sample site locations (2005-2007) within the Daniel Boone National Forest, Kentucky.

Table 1. Number of sample sites with inventories and the distance inventoried by year.

Year	Sites (#)	Inventory Distance (km)
2005	20	5.1
2006	34	8.7
2007	12	2.9
Total	66	16.7

Table 2. Summary of parameters inventoried at stream sample locations in 2005.

Site	Stream Name	Macro-inverts	Pebble Count RSI	Pebble Count D50 (mm)	BVET habitat (m)	Efish (sec)	Mussels	Crayfish	Comments
1	Rock Creek	collected	75	52	299	2,747	none	collected	
9	Marsh Creek	--	--	--	--	--	--	present	No survey, too large
14	Pine Creek	collected	86	42	226	1,408	none	present	
17	Rock Creek	collected	85	38	305	2,566	none	collected	
21	Roaring Paunch Creek	--	--	--	--	--	--	--	No survey, too large
33	Rock Creek	collected	73	58	311	3,356	collected	collected	
34	Bunches Creek	collected	19	680	218	--	--	present	No efishing, blackside dace stream
38	Cane Creek	collected	58	92	305	3,877	none	collected	
41	Jellico Creek	collected	75	34	173	745	collected	collected	
42	Big Clifty Creek	collected	84	8	299	2,037	none	present	
45	Beaver Creek	collected	96	14	143	--	--	--	No efishing, blackside dace stream
53	Laurel Creek	collected	90	70	253	1,638	none	present	Efish mistake, blackside dace stream
61	Beaver Creek	--	--	--	--	--	--	--	No survey, tick hazard
62	Horse Lick Creek	collected	75	54	297	1,620	collected	collected	
65	Rock Creek	collected	64	118	279	2,805	none	collected	
66	Beaver Creek	--	--	--	--	--	--	--	No survey, too large
75	Indian Creek	--	--	--	--	--	--	--	No survey, dry stream in karst area
78	Hawk Creek	collected	85	30	261	--	--	--	No efishing, water too turbid
85	Roaring Paunch Creek	collected	69	82	325	3,000	collected	present	
90	Craig Creek	collected	NA*	1024	302	--	--	--	No efishing, blackside dace stream
93	Middle Fork (Beaver Cr)	collected	68	14	200	--	none	present	No efishing, blackside dace stream
97	Roaring Paunch Creek	--	--	--	--	--	--	--	No survey, too large
98	Dog Slaughter Creek	collected	NA*	1024	163	--	none	present	No efishing, blackside dace stream
105	Capuchin Creek	collected	62	38	325	2,611	collected	collected	
109	Kilburn Fork	collected	69	34	141	--	--	--	No efishing, blackside dace stream
117	Laurel Creek	collected	74	44	311	--	--	--	No efishing, blackside dace stream
				Total	5,136				

*Riffle Stability Index (RSI) not available because no bars were present for bar count.

Table 3. Summary of parameters inventoried at stream sample locations in 2006.

Site	Stream Name	Macro-inverts	Pebble Count RSI	Pebble Count D50 (mm)	BVET habitat (m)	Efish (sec)	Mussels	Crayfish	Comments
7	South Fork Kentucky River	--	--	--	--	--	--	--	Not surveyed, too large
32	Yocum Creek	collected	100	64	304	2,108	none	present	
35	Red Bird River	--	--	--	--	--	--	--	Not surveyed, too large
40	Open Fork	--	--	--	--	--	--	--	Not surveyed, too large
48	North Fork Licking River	collected	94	72	276	2,824	collected	collected	
55	Bullskin Creek	collected	81	66	268	772	none	collected	
59	Cavanaugh Creek	collected	93	54	293	1,480	none	collected	
64	Minor Creek	collected	92	56	213	1,300	none	collected	
67	Rock Lick Creek	--	--	--	--	--	--	--	Not surveyed, private land
68	Chimney Top Creek	collected	99	38	218	764	none	present	
72	Beaver Creek	collected	97	24	415	1,842	none	present	
79	Sand Lick Fork	collected	97	50	193	953	none	present	
84	Swift Camp Creek	collected	74	88	322	2,479	none	present	
99	Upper Jacks Creek	collected	84	60	300	1,739	none	collected	
123	Ross Creek	collected	70	80	124	427	none	collected	
135	Red Bird River	--	--	--	--	--	--	--	Not surveyed, too large
136	Beaver Creek	collected	96	24	374	2,700	none	collected	
148	Red River	--	--	--	--	--	--	--	Not surveyed, too large
159	Middle Fork Red River	collected	82	60	215	1,000	none	collected	
160	Upper Lick Fork Creek	collected	93	54	129	336	none	collected	
175	Red River	--	--	--	--	--	--	--	Not surveyed, too large
176	Craney Creek	collected	89	8	377	2,252	none	collected	
179	Red Bird River	--	--	--	--	--	--	--	Not surveyed, too large
183	Leatherwood Creek	collected	52	112	230	998	none	present	
191	East Fork Indian Creek	collected	88	66	256	1,061	none	collected	

Table continued on next page.

Table 3 Continued. Summary of parameters inventoried at stream sample locations in 2006.

Site	Stream Name	Macro-inverts	Pebble Count RSI	Pebble Count D50 (mm)	BVET habitat (m)	Efish (sec)	Mussels	Crayfish	Comments
192	Clear Fork	collected	78	126	223	1,002	none	collected	
195	Collins Fork	--	--	--	--	--	--	--	Not surveyed, too deep
196	Gladie Creek	collected	93	48	443	2,456	none	present	
199	Bowen Creek	collected	90	58	124	413	none	collected	
200	Brushy Fork	collected	84	88	200	707	none	collected	
207	Right Fork Buffalo Creek	collected	76	60	198	788	none	collected	
224	North Fork Licking River	collected	98	40	357	2,403	collected	none	
239	Indian Creek	collected	93	50	251	1,398	none	collected	
240	Slabcamp Creek	collected	99	40	213	751	none	collected	
251	Big Sinking Creek	collected	77	160	320	1,796	none	collected	
275	Phillips Fork	collected	59	96	277	1,165	none	collected	
283	War Fork	collected	88	66	463	2,137	none	present	
288	Craney Creek	collected	99	20	322	2,965	collected	collected	Live Corbicula clams
307	Hector Branch	collected	58	114	268	1,910	none	collected	
NA	Gilberts Big Creek	collected	92	52	105	290	none	collected	site # DBF04052007
NA	Katies Creek	collected	75	58	195	823	none	collected	site # DBF04051009
NA	Sugar Creek	collected	92	46	109	362	none	collected	site # DBF04052030
NA	Upper Bear Creek	collected	45	210	158	654	none	collected	site # DBF04052701
				Total	8,730				

Table 4. Summary of parameters inventoried at stream sample locations in 2007.

Site	Stream Name	Macro-inverts	Pebble Count RSI	Pebble Count D50 (mm)	BVET habitat (m)	Efish (sec)	Mussels	Crayfish	Comments
117	Laurel Creek	collected	54	106	190	956	none	collected	
133	Big Creek	collected	55	104	265	1,669	none	collected	
137	Barren Fork	collected	78	32	279	--	none	--	No efishing, blackside dace stream
178	Bark Camp Creek	collected	15	1024	225	1,392	none	collected	
201	Indian Creek	collected	69	80	277	--	none	--	No efishing, blackside dace stream
218	Lick Creek	collected	94	18	189	728	none	collected	
258	Mill Creek	collected	73	80	232	1,146	none	collected	
278	Cane Creek	collected	59	88	260	1,222	none	collected	
290	Bark Camp Creek	collected	42	380	252	1,542	none	collected	
293	Bridge Fork	collected	50	126	201	868	none	collected	
305	Wolf Creek	collected	54	108	181	738	none	collected	
314	Sinking Creek	collected	37	140	300	2,056	present	collected	
				Total	2,851				

Literature Cited

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Olsen, T. 2005. Daniel Boone National Forest, Kentucky, Stream survey design. Unpublished Report. Corvalis, Oregon: U.S. Environmental Protection Agency, Western Ecology Division.

Pratt, J. W. 2002. Methods for assessing biological integrity of surface waters. Kentucky Department for Environmental Protection. Division of Water, Ecological Support Division, Frankfort, KY.

Roghair, C. N. and D. R. Nuckols. 2005. Guide to stream habitat characterization using the BVET methodology in the Daniel Boone National Forest, KY. Unpublished Report. Blacksburg, Virginia: U.S. Department of Agriculture, Forest Service, Center for Aquatic Technology Transfer.

Walker, J. A., and V. Bishop. 1991. Daniel Boone National Forest stream monitoring inventory work plan and sampling techniques manual. Richmond, Kentucky: U.S. Department of Agriculture, Forest Service, Southern Region.

Appendix A: Field Methods for Stream Inventory

Sampling Strategy

Day 1

- All crew to first site to learn site documentation, reach layout, and macroinvertebrate and habitat sampling methods
- Split into several crews to document sites, layout reaches, and sample macroinvertebrates and habitat

Day 2

- Two crew continue with site documentation, reach layout, and macroinvertebrate and habitat sampling methods
- Remainder of crew (6-8 persons) begin fish sampling at sites visited on day 1

Day 3

- Continue with approach from day 2, allowing at least 1 day between macroinvertebrate and fish sampling
- If fish sampling crew catches up with layout crew, then take a day to split into several layout crews as during day 1
- When layout crew finishes all sites they can rejoin fish sampling crew

This approach should maximize crew efficiency and prevent biases associated with sampling fish and macroinvertebrates within the same reach in the same day.

Site Documentation

Objective - Record location and description of site for reporting purposes

Methods

- Directions to site
    - Record roads taken to parking area
    - Record trails walked to site
    - Document route to site on quadrangle map

- GPS
    - Record GPS coordinates at middle of reach
    - Use Daniel Boone National Forest standard for coordinate system and map datum; example) CONUS, NAD27

- Photos
    - Take digital photo from downstream end looking up, upstream end looking down
    - Photograph any pertinent features within the reach that may influence habitat and fauna, example, road or trail crossings, erosion, etc.

- Written description
    - Record comments on land use in the reach area, for example private land with mowed lawns, all forested, pasture lands, etc.
    - Record comments on other features that may be influencing stream conditions

Fish Reach Layout

Objective - Use consistent method to lay out reach for fish and macroinvertebrate sampling

Methods

- Locate 1 – 2 riffles or runs and determine the average wetted width by making several measurements and computing the average. Measure width perpendicular to thalweg.
    - If the average wetted width is less than or equal to 3.0 m, then the reach length will be 120 m
    - If the average wetted width is greater than or equal to 7.5 m, then the reach length will be 300 m
    - If the average wetted width is between 3.0 and 7.5 m, then reach length is 40-times the average wetted width, example: average wetted width = 5 m; reach length = 5 x 40 = 200m

- Hang a double orange flag at the downstream end of the reach . Attach topofil from a hipchain and walk to the midpoint of the reach, hang a single orange flag, then continue to the end of the reach and hang another single orange flag

- Record the average wetted width and reach length on the datasheet

- Reaches will not be moved to avoid road or trail crossings – moving reaches violated the assumptions of the stratified random sample desing and invalidates statistical analysis. Document these features fully with photos and written descriptions

- Always begin reaches at the downstream end of a defined habitat unit, end points should be at the exact distance as described above

- In large streams make sure the reach includes all of a fast water habitat unit and all of a slow water habitat unit

Macroinvertebrates Inventory

Objective - Collect assemblage sample

Methods

- Using D-frame nets and a seine collect macroinvertebrates using the riffle sample and multi-habitat sample methods described by Pratt (2002)

- Where possible, keep macroinvertebrate samples within designated reaches. If this is not possible be sure to indicate on datasheet.

Pratt, J. W. 2002. Methods for assessing biological integrity of surface waters. Kentucky Department for Environmental Protection. Division of Water, Ecological Support Division, Frankfort, KY.

(see pages 53 – 59 for macroinvertebrate sampling methods)

Pebble Count Inventory

Objective - Determine the riffle stability index (RSI), bar sample geometric mean, and median particle sizes.

Methods

- Pebble count data is collected using methods modified from those in Kappesser (2002) to characterize the substrate composition of sample reaches

- Pebble counts are performed in riffles designated for electrofishing by walking transects perpendicular to the flow within the bankfull channel (Harrelson et al. 1994)

- Walk the transect beginning at the edge of the bankfull channel on one side of the stream and walk heel-to-toe across the stream channel to the opposite bank

- At each step pick up the pebble at the tip of your toe and measure its intermediate axis with a ruler to the nearest millimeter

- For very large particles, the same particle is counted as many times it is encountered

- These procedures are repeated until at least 100 measurements are recorded. Transects are not terminated until the opposite bank is reached even if this results in more than 100 measurements.

- Transects are distributed throughout the riffle. If detritus, LW, or other organic materials are encountered the rock substrate found directly below them is sampled.

Bunte, K. and S. R. Abt. 2001. Sampling surface and subsurface particle-size distributions in wadable gravel- and cobble-bed streams for analyses in sediment transport, hydraulics, and streambed monitoring. General Technical Report RMRS-GTR-74. Fort Collins, CO: U. S. Deparment of Agriculture, Forest Service, Rocky Mountain Research Station.

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Kappesser, G. B. 2002. A riffle stability index to evaluate sediment loading to streams. Journal of the American Water Resources Association. 38:1069-1081.

Habitat Inventory

Objective – Characterize stream habitat attribute within the sample reach.

Methods

- Collect attribute as described in Section 2 of Roghair and Nuckols (2005) (Appendix B)

- Increase frequency of paired (sub-) samples to include at least 3 fast and 3 slow water units within each reach
    - Where less than 3 fast or slow occur, sub-sample all units

- Start and end data collection at habitat unit breaks
    - This may extend habitat data collection slightly beyond end of sample reach

Electrofishing Inventory

Objective - Determine relative abundance and determine catch-per-unit-effort (CPUE). Note: we are not attempting to estimate population size or density for individual species, only assessing the fish assemblage

Methods (based on sampling strategies discussed and approved by R8 and SRS personnel in 3/2005)

- Electrofishing starts in same location as habitat inventory

- Electrofishing ends at location designated in reach layout process
    - Habitat inventory may extend beyond end of designated reach
    - DO NOT extend electrofishing sample beyond end of designated reach

- Single-pass DC backpack electrofishing

- One shocker, 3 netters

- No blocknets

- Electrofishing effort will be equal to 1.0 seconds for each 1.0 m^2 of wetted area
    - note: this will standardize our effort and remove the potentially confounding effect of changes in wetted width relative to the bankfull channel width in wet or dry years
    - derived Warren et al. data on electrofishing effort in MS streams

- Fish will be counted and released at the site, except for a voucher specimen for each species; endangered species lists will be reviewed before sampling

- Record age-0 fish and all fish older than age-0 separately for each species

- Keep all relic mussel shells encountered

- Keep all crayfish captured, review endangered species lists before sampling

Appendix B: Field Methods for Habitat Inventory

Methods for Stream Habitat Characterization using the BVET Methodology in the Daniel Boone National Forest, KY

Prepared by:

Prepared by: Craig N. Roghair and Daniel R. Nuckols

2005

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Introduction

The basinwide visual estimation technique (BVET) is a versatile tool used to assess streamwide habitat conditions in wadeable size streams and rivers. A crew of two individuals performs the inventory using two-stage visual estimation techniques described in Hankin and Reeves (1988) and Dolloff et al. (1993). In its most basic form the BVET combines visual estimates with actual measurements to provide a calibrated estimate of stream area with confidence intervals, however the crew may inventory any number of other habitat attributes as they walk length of the stream. Experienced crews can inventory an average of 2.0 – 3.0 km per day, but this will vary depending on stream size and the number of stream attributes inventoried.

Before a crew begins a BVET inventory they must receive adequate training, both in the classroom and in the field. Estimating and measuring a large number of habitat attributes can confuse and overwhelm an inexperienced crew. Individuals must have an understanding of the basic concepts behind the BVET and be familiar with habitat attributes before they can effectively and efficiently perform an inventory.

In summer 2004, resource managers on the Daniel Boone National Forest (DBNF) requested that the USFS Center for Aquatic Technology Transfer (CATT) implement modified BVET inventories to inventory stream reaches previously inventoried in the 1990's. The 1990's inventories followed methods detailed in the 'Daniel Boone National Forest Stream Inventory Work Plan and Sampling Techniques Manual', which were similar in nature to the BVET habitat inventory. After discussion with resource managers from the DBNF, we scaled down the original protocol, eliminating several attributes and modifying others to maximize inventory efficiency during our limited time on the Forest. In summer 2005 the DBNF opted to use identical BVET methods as National Forests in Virginia and North Carolina, which are only slightly different from methods used in Kentucky in 2004.

This document was developed to serve as a guide for classroom and field instruction for the DBNF BVET habitat inventory and to provide a post-training reference for field crews. It includes an overview of the BVET inventory, defines habitat attributes, instructs how and when to measure attributes, and provides reference sheets for use in the field. Each trainee should receive a copy of this manual and is encouraged to take notes in the spaces provided.

We used an abbreviated version of the BVET to sample habitat within sample reaches only. Paired samples were collected more frequently then described here because reaches were short. Stream attributes were collected as described in Section 2.

References cited in this manual:

Armantrout, N. B., compiler. 1998. Glossary of aquatic habitat inventory terminology. American Fisheries Society, Bethesda, Maryland.

Bunte, K., and S. R. Abt. 2001. Sampling surface and subsurface particle-size distributions in wadable gravel- and cobble-bed streams for analyses in sediment transport, hydraulics, and streambed monitoring. General Technical Report RMRS-GTR-74. Fort Collins, Colorado: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

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Rosgen, D.L. 1996. Applied River Morphology. Wildland Hydrology Books, Pagosa Springs, Colorado.

Rosgen, D.L., and L. Silvey. 1998 Field Guide for Stream Classification, Wildland Hydrology Books, Pagosa Springs, Colorado.

Changes to BVET inventory in 2005

Attribute	Action	Reason
Substrate	Modified	Substrate categories changed from those in Daniel Boone National Forest Stream Inventory Work Plan and Sampling Techniques Manual to those used during BVET inventories in National Forests in North Carolina and Virginia

Other minor changes, mostly modifications in terminology and definitions to provide increased clarity, are found throughout the manual.

Outline of BVET Habitat Inventory

The inventory is comprised of the following steps:

1) Enter 'header' information in the data sheet
    - 'Header' information includes date, stream, start location, crew, etc. and is **vitally** important to record for future reference

2) Select an appropriate measurement interval and a random number
    - In streams < 1.0 km measure every 5th unit (random number 1-5), in streams > 1.0 km measure every 10th unit (random number 1-10)
    - The random number designates the first habitat unit (i.e. the paired sample unit) in which the crew will perform measurements

3) Enter downstream of the starting point, then move upstream and begin the inventory
    - Tie off the hipchain, proceed upstream to the starting point, reset the hipchain to zero, and proceed upstream estimating parameters and recording data in every habitat unit

4) At the paired sample unit perform visual estimates, then perform measurements
    - If the random number '3' were chosen, the crew would stop after making estimates in the 3rd pool (and 3rd riffle) and perform the necessary measurements

5) Progress upstream estimating attributes for every unit until the next paired sample unit is reached, then repeat step 4
    - In the above example, if the interval were 10 units, the crew would stop at the 13th, 23rd, 33rd, etc. pool (and 13th, 23rd, 33rd, etc. riffle) and repeat measurements done in pool 3 and riffle 3.
    - The crew should also take care to record roads, trails, tributaries, dams, waterfalls, road crossing types, riparian features (wildlife openings, trails, campsites, roads, timber harvest, etc.), and other pertinent stream features as they progress upstream. Be sure to record hipchain distances when noting such features.

Repeat steps 4 and 5 until the end of the stream is reached.

The following sections describe the BVET habitat inventory in detail:

Section 1: Getting Started – equipment lists, header information, random numbers, starting the inventory

Section 2: Habitat Attributes – definitions, how to estimate or measure, when to record

Section 3: Wrapping Up – what to do when the inventory is completed

Appendix: field guide, random number tables, equipment checklist

Section 1: Getting Started

Equipment List

Hipchain	camera
extra string for hipchain	backpack
wading rod	pencils
50 m tape measure	flagging
Clinometer	markers
Datalogger	waterproof backup datasheets
Thermometer	clipboard
GPS unit	BVET manual and field guide
topographic map	felt bottom wading boots or waders

Other useful equipment: lunch, water, water filter, 1st aid kit, toilet paper, rain gear, radio/cell phone

The crew consists of two individuals, the 'observer' and the 'recorder'. The observer wears the hipchain and carries the wading rod. The recorder wears the data logger and carries other equipment in the backpack. The duties of each individual are listed below.

Duties

Observer	Recorder
Designate habitat units	Record data
Measure distance	Determine paired sample location
Estimate width	Classify and count LW
Estimate depths	Photo-documentation
Classify substrates	Document features
Estimate Rosgen channel type	
Estimate percent fines	

Both crew members are needed to measure actual widths, channel widths, riparian areas, gradient, and water temperature at designated units. Although the crew has assigned duties, they should not hesitate to consult with each other if they have questions or feel that a mistake may have been made. Working as a team will provide the best possible results.

Header Information

Header information is **vitally important** for future reference. Take the time to record all categories completely and accurately.

Stream Name	Full name of stream
District	National Forest District name
Quad	USGS 1:24,000 quadrangle name
Date	Record date(s) of inventory
Recorder	Full name of recorder
Observer	Full name of observer
GPS	record at start and end locations, always use NAD27 CONUS, UTM
Location	**Detailed** written description of start point, include landmarks, road #, etc.
Notes	Record signs of activity in area, water conditions, other pertinent information

Random Numbers

Before beginning the inventory, select a number from a random numbers table (see Appendix) to determine the first habitat unit at which to make measurements. For long inventories (> 1.0 km) select a random number between 1 and 10th (i.e. measure every 10 unit), for shorter streams use a number between 1 and 5 (i.e. measure every 5th unit). See the appendix for random numbers tables.

The crew needs to measure units more frequently during shorter inventories to provide enough 'paired samples' for data analysis. 'Paired samples' are habitat units in which both visual estimates and actual measurements are made. The more paired samples, the tighter the confidence intervals for stream area estimates.

After the crew records a paired sample they continue upstream making visual estimates and stopping to make additional measurements at the pre-determined interval. For example, if the random number was 3 and the crew was measuring every 5th unit, the crew would make measurements on the 3rd pool and 3rd riffle and then every 5th pool and riffle thereafter (8, 13, 18, 23, etc).

Starting the Inventory

After the crew has organized their gear, determined their measurement interval, selected a random number, and recorded all the header information they are ready to begin the habitat inventory. The observer should enter the stream slightly downstream of the starting point, tie off the hipchain, progress upstream to the starting point, reset the hipchain to zero and begin walking upstream through the first habitat unit. As the observer moves upstream they use the wading rod to measure depth at several locations in the habitat unit and make observations of unit type, width, substrates, Rosgen channel type, and percent fines. When they reach the upstream end of the habitat unit they stop, report the distance, then turn to face the unit and report the unit type, estimated width, maximum and average depth, riffle crest depth (where appropriate), dominant and subdominant substrate classes, Rosgen channel type, and percent fines to the recorder.

As the observer moves upstream through the unit, the recorder follows behind, recording the amount of LW in the habitat unit. The recorder also assigns a number to the habitat unit. The recorder tells the observer if a unit is designated for measurements (i.e. if it is a 'paired sample' unit) only after they have recorded visual estimates.

The crew continues upstream making estimates in every habitat unit and making estimates and measurements in every paired sample unit until the inventory endpoint is reached.

Definitions of habitat attributes, how to measure and when to record them, and what to do when the inventory is complete are covered in the following sections.

Section 2: Stream Attributes

Unit Type (see abbreviations)

Definitions:*

Unit Type	Abbreviation	Definition
Riffle	**R**	**Fast water, turbulent, gradient <12%**; shallow reaches characterized by water flowing over or around rough bed materials that break the surface during low flows; also **include rapids** (turbulent with intermittent whitewater, breaking waves, and exposed boulders), **chutes** (rapidly flowing water within narrow, steep slots of bedrock), and **sheets** (shallow water flowing over bedrock) if gradient <12%
Cascade	**C**	**Fast water, turbulent, gradient ≥12%**; highly turbulent series of short falls and small scour basins, with very rapid water movement; also **include sheets** (shallow water flowing over bedrock) and **chutes** (rapidly flowing water within narrow, steep slots of bedrock) if gradient ≥12%
Run	**RN**	**Fast water, non-turbulent, gradient <12%**; deeper than riffles with little or no surface agitation or flow obstructions and a flat bottom profile
Pool	**P**	**Slow water, surface turbulence may or may not be present, gradient <1%**; generally deeper and wider than habitat immediately upstream and downstream, concave bottom profile; **includes dammed pools, scour pools, and plunge pools**
Glide	**G**	**Slow water, no surface turbulence, gradient <1%**; shallow with little to no flow and flat bottom profile
Underground	**UNGR**	Stream channel is dry or not containing enough water to form distinguishable habitat units

*modified from Armantrout (1998)

How to estimate:

Habitat units are separated by 'breaks'. Breaks can be obvious physical barriers, such as a debris dam separating two pools or a small waterfall separating a pool and riffle, or may be less obvious transitional areas. Questions often arise as to whether a break is substantial enough to split two habitat units and where the exact location of the break occurs. When in doubt, the observer should consult with the recorder and the team should 'think like a fish'. To determine if a break should be made, consider whether a fish would have to make an effort to move across the break and into the next habitat unit. If not, then it is probably a single habitat unit.

The channel may have both pool and riffle type habitat in the same cross-sectional area. Determine the predominate habitat type and record it as the unit type. For example if an area contains both pool and riffle, but the majority of the flow is into and out of the pool habitat, then call a pool.

Questions also often arise as to the minimum size of individual habitat units. Generally, if a habitat unit is not at least as long as the wetted channel is wide, then do not count it as a separate habitat unit. This rule may need to be adjusted for streams wider than 5 m. Use best professional judgment in such cases.

See the section 2.1 for a list of features that should also be recorded while performing the inventory.

When to record: every habitat unit

Unit Number (#)

Definition:
Count of habitat units of similar types, used to determine location of paired sample units.

How to estimate:
When counting habitat units, group pools and glides (slow water) together, and group riffles, runs, and cascades (fast water) together. For example, consider the following sequence of habitat units:

Pool – Riffle – Pool – Pool – Riffle - Cascade – Riffle - Glide – Riffle – Pool – Run – Pool – Riffle

Habitat units in this sequence would be counted in the following manner (similar types are shaded same color):

Unit Type	Unit Number
P	1
R	1
P	2
P	3
R	2
C	3
R	4
G	4
R	5
P	5
RN	6
P	6
R	7

In the above example, the crew has counted six slow water (pool/glide) units and seven fast water (riffle/run/cascade) units.

If '3' were chosen as the random number and the measuring interval was every 10th unit, the crew would estimate and then measure habitat data for Pool 3 and Cascade 3 (i.e. Pool 3 and Cascade 3 are 'paired sample' units). When the crew reaches pool or glide 13 and riffle, run, or cascade 13, they would repeat procedures followed in the 3rd units.

When to record: every habitat unit; not recorded for features such as falls, tributaries, side channels, culverts, etc.

Distance (m)

Definintion:
Number of meters from the start of the inventory to the upstream end of the habitat unit or distance from the start of the inventory to upstream end of a feature, used as spatial reference for data analysis and to locate features in the future.

How to estimate:
The observer walks upstream in the middle of the stream channel with a hipchain measuring device. When they reach the upstream break between habitat units or the upstream end of a feature they stop and report the distance to the recorder.

Care should be taken to keep the hipchain string in the middle of the stream, especially around bends and meanders. If the hipchain should break, retreat to the location where the break occurred, tie off the hipchain, and continue. If the hipchain is reset for any reason be sure to note it in the comments.

When to record: every habitat unit and feature

Estimated Width (m)

Definition:
Average wetted width of the habitat unit as estimated visually, used to calculate stream area. Wetted width is the distance from the edge of the water on one side of the main channel to the edge of the water on the opposite side of the main channel.

How to estimate:
The observer notes the general shape and width of the unit while walking to the upstream end. When they reach the upstream end of the unit the observer stops, turns to face the unit, and estimates the average wetted width. Measure the wetted width of the stream before starting each day to calibrate yourself.

When to record: every habitat unit

Maximum and Average Depth (cm)

Definitions:
Maximum Depth: vertical distance from substrate to water surface at deepest point in habitat unit
Average Depth: average vertical distance from substrate to water surface in habitat unit.

How to estimate:
The observer uses a wading rod marked in 5 cm increments to measure water depth as they walk upstream through the habitat unit. Water depth in deepest spot is recorded as the maximum depth. Average depth is the average of several depth measurements taken throughout the habitat unit.

When to record: every habitat unit

Riffle Crest Depth (cm)

Definition:
Vertical distance from the substrate to the water surface at the deepest point in the riffle crest. The riffle crest is the shallowest continuous line (usually not straight) across the channel where the water surface becomes continuously riffled in the transition area between a riffle (or a run or cascade) and a pool (or glide) (Armantrout 1998); think of it as the last place water would flow out of the pool if the riffle ran dry.

How to estimate:
When the observer reaches the upstream end of a riffle (or a run or cascade) leading into a pool (or glide), they use the wading rod to measure the deepest point in the riffle crest. Record the depth in the RCD column for the riffle habitat row.

When to record: at the upstream end of any riffle, run, or cascade leading into a pool or glide

Dominant and Subdominant Substrate (1-9)

Definitions:

Dominant Substrate: size class of stream bed material that covers the greatest amount of surface area within the wetted channel of the habitat unit.

Subdominant Substrate: size class of stream bed material that covers the 2nd greatest amount of surface area within the wetted channel of the habitat unit.

How to estimate:

The following size classes are used to categorize substrates*. The substrate 'Number' is entered into the dominant and subdominant substrate columns on the datasheet.

Type	Number	Size (mm)	Description
Organic Matter	1		dead leaves, detritus, etc. – **not live plants**
Clay	2		sticky, holds form when rolled into a ball
Silt	3		slippery, does not hold form when rolled into a ball
Sand	4	silt – 2	grainy, does not hold form when rolled into ball
Small Gravel	5	3-16	sand to thumbnail
Large Gravel	6	17-64	thumbnail to fist
Cobble	7	65-256	fist to head
Boulder	8	>256	larger than head
Bedrock	9		solid rock, parent material, may extend into bank

** these size classes are based on the modified Wentworth scale*

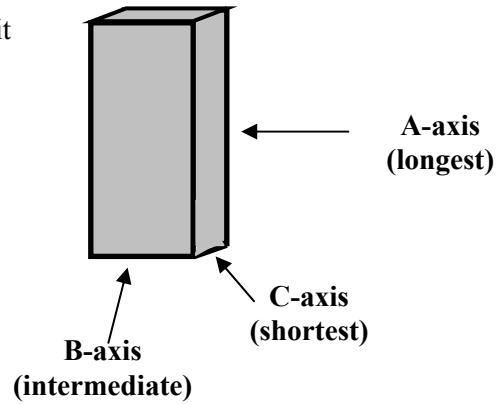
As the observer walks through the unit they scan the substrate. When they reach the upstream end of the unit they stop, turn to face the unit, and determine the dominant and subdominant substrate classes.

Estimate substrate size along the intermediate axis (b-axis). The b-axis is not the longest or shortest axis, but the intermediate length axis (see below). It is the axis that determines what size sieve the particle could pass through. Remember that your eyes are naturally drawn to larger size substrates. Be careful not to bias your estimate by focusing on the large size substrate.

Some units will contain a mixture of particle sizes. Consult with the recorder and use your best professional judgment to choose the dominant and subdominant sizes.

In units where the substrate is covered in moss, algae, or macrophytes classify the underlying substrate and make note of the plant growth in the comments. Only call organic substrate where there is dead and down leaves or other detritus covering the bottom of the unit.

When to record: every habitat unit



Rosgen Channel Type (A-G)

Definitions:
Stream channel classification system described in Rosgen (1996) based on entrenchment, width/depth ratio, sinuosity, and percent slope.

How to Measure:
Before the crew begins the inventory they should make the measurements described below to determine the channel type. Channel types are based on the following channel characteristics:

	A	B	C	D	E	F	G
Entrenchment	< 1.4	1.4 – 2.2	> 2.2	n/a	> 2.2	< 1.4	< 1.4
W/D Ratio	< 12	> 12	> 12	> 40	< 12	> 12	< 12
Sinuosity	1 – 1.2	> 1.2	>1.2	n/a	> 1.5	> 1.2	> 1.2
Slope (%)	4 – 9.9	2 – 3.9	< 2	< 4	< 2	< 2	2 – 3.9

Although we record channel type for every unit, it was designed to describe a reach of stream. Our main objective here is to locate changes between channel types, which could either be abrupt (such as change from a B to a G near a road crossing) or less obvious transitional areas (such as a natural transition from a B to an A channel as you move upstream). If you think channel type may have changed take the time to make the calculations listed below to determine the channel type for the reach you are entering.

Full channel type descriptions and how to measure each of the channel characteristics in the table above can be found in Rosgen (1998). Never perform measurements in a pool, always attempt to find a run or deep riffle with well-defined bankfull indicators to perform measurements. A summary of each is listed below:

Entrenchment (page 31 & 32 in Rosgen field guide):
- locate suitable riffle or run area for bankfull measurement (page 24-25 in Rosgen field guide)
- measure the bankfull width the maximum bankfull depth
- stretch a tape across the channel at 2x the maximum bankfull depth (this is the flood prone area)
- divide the flood prone area width by the bankfull width to determine entrenchment ratio

Width to Depth Ratio (page 32 in Rosgen field guide):
- locate suitable riffle or run area for bankfull measurement (page 24-25 in Rosgen field guide)
- measure the bankfull width and the maximum bankfull depth
- divide bankfull width by depth to determine width to depth ratio

Sinuosity (need aerial photo to determine)

Slope (page 37 in Rosgen field guide):
- Measure riffle to riffle gradient using clinometer

When to measure: every habitat unit*
* record for every unit, but remember this is describing a reach characteristic – see above

Rosgen, D.L. 1996. Applied River Morphology. Wildland Hydrology Books, Pagosa Springs, Colorado.

Rosgen, D.L., and L. Silvey. 1998 Field Guide for Stream Classification, Wildland Hydrology Books, Pagosa Springs, Colorado.

Percent Fines (%)

Definition:
Percent of the total surface area of the stream bed in the wetted area of the habitat unit that consists of sand, silt, or clay substrate particles (i.e. particles < 2 mm diameter).

How to estimate:
As the observer walks through the habitat unit they note the amount of sand, silt, and clay in the habitat unit. When they reach the upstream end of the unit, they stop, turn to face the unit and estimate the amount of the total surface area within the wetted channel that consists of sand, silt, or clay.

Where to estimate: every habitat unit

Large Wood (1-4 and rootwad)

Definition:
Count of dead and down wood within the bankfull channel of a habitat unit

How to estimate:
The recorder classifies and counts LW as they walk through the habitat unit. LW counts are grouped by the size classes listed below:

Category	Length (m)	Diameter (cm)	Description
1	1-5	10-55	short, skinny
2	1-5	>55	short, fat
3	>5	10-55	long, skinny
4	>5	>55	long, fat
RW	rootwad	rootwad	roots on dead and down tree

Only count wood that is:
- > 1.0 m in length and > 10.0 cm in diameter
- within the bankfull channel
- fallen, not standing dead

- Count rootwads separately from attached pieces of LW
- Estimate the diameter of LW at the widest end of the piece
- A piece that is forked, but is still joined counts as only one piece of LW
- Only count each piece one time, do not count a piece that is in two habitat units twice
- Enter the total count for each size category into the appropriate column on the datasheet

Where to estimate: every habitat unit

Actual Width (m)

Definition:
Average wetted width of the habitat unit as measured with 50 m tape, used to calculate stream area. Wetted width is the distance from the edge of the water on one side of the main channel to the edge of the water on the opposite side of the main channel.

How to measure:
Use a meter tape to measure the wetted width of the stream in at least three locations. Average the measurements to obtain the average wetted width.

Where to measure: paired sample habitat units

Bankfull Channel Width (m)

Definition:
Average width of channel at bankfull elevation as measured with meter tape. Depending on channel type, bankfull may or may not be represented by the top of the banks. Use bankfull indicators to locate the top of the bankfull channel (Rosgen 1996).

How to measure:
Determine the location of bankfull water depth on both banks of the habitat unit and measure across the channel perpendicular to flow from bankfull to bankfull. Make at least three measurements across the bankfull channel.

Where to measure: paired sample riffles, runs, or cascades

Riparian Width (m)

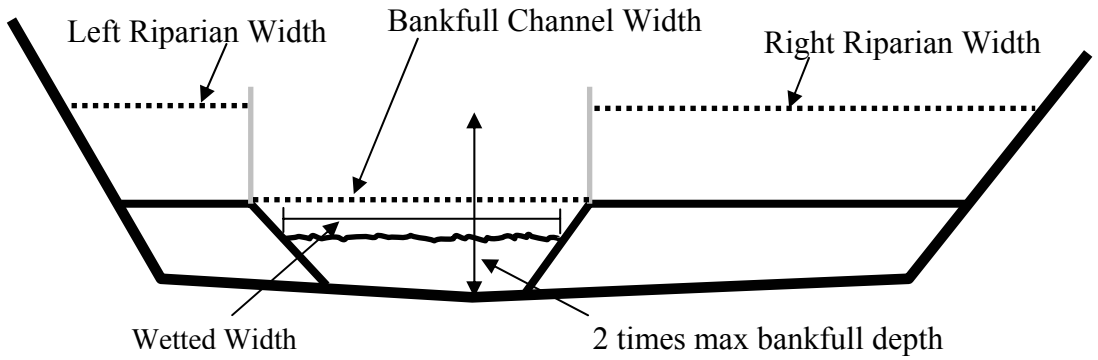
Definition:
Width of the riparian area at an elevation of two times the maximum bankfull depth, measured for both left and right banks (left and right as oriented facing upstream). Maximum bankfull depth is the greatest vertical distance from the substrate to the top of the bankfull channel across a bankfull transect.

How to measure:

1. Stretch a measuring tape across the top of the bankfull channel – this is your bankfull transect
2. Use a wading rod to find the maximum bankfull depth
3. Place the clinometer against the wading rod at two-times the maximum bankfull depth
4. Using the clinometer to maintain a slope of zero degrees, site perpendicular to the channel to the intersection with the nearest landform. It may be necessary to site to an intermediate point, move the wading and clinometer, and site again if the tape measure is too short or the view is obstructed
5. Measure the distance from the edge of the bankfull channel to the landform – do this separately for the left and right (as facing upstream) riparian areas

Note: if riparian width is more than 50 m, record 51 as the riparian width and note in 'Comments' that riparian width was longer than meter tape

Where to measure: paired sample riffles, runs, or cascades



Gradient (%)

Definition:
Change in vertical elevation per unit of horizontal distance of the water surface (Armantrout 1998).

How to measure:
Gradient is measured in riffles with a clinometer using the following steps:

1) observer stands at upstream end of riffle, recorder stands at downstream end of riffle
2) recorder sites upstream to the height of their eye on the observer using clinometer
3) record the **percent** slope, **not the degrees** (tip the clinometer all the way back to determine which side of the scale is percent)

The recorder should determine the height of their eye on the obsrever at the beginning of the inventory. Be certain that the observer and recorder are standing with their feet in the same position (preferably with feet at top of water surface) within the stream channel. If the observer is standing on top of a boulder and the recorder is standing in a depression, the measured gradient will be incorrect.

Where to measure: paired sample riffles, runs, or cascades

Water Temperature (C)

Definition:
Temperature of the water in degrees Celsius.

How to measure:
Place the thermometer in moving water in an area not exposed to direct sunlight. Leave the thermometer sit for at least three minutes, then record the water temperature in degrees Celsius.

Where to measure: paired sample riffles, runs, or cascades

Photo (y or n)

Definition:
Photograph of habitat unit or crossing feature.

How to measure:
Take photo facing upstream with observer holding wading rod in picture. Be sure to get entire width (and length if possible) of habitat unit or crossing feature in the photo.

Where to measure: paired sample riffles, runs, or cascades and any crossing features encountered

Features

Definition:
Points on a stream that could potentially serve as landmarks, may be natural or manmade.

How to measure:
Record the distance to the upstream end of a feature; record distance of **all features** (both stream and crossing features) in the regular habitat datasheet; also record additional measurements for crossing features in the crossing datasheet and take a photograph of all crossing features.

Where to record: wherever found

Channel Feature	Abbreviation	What to Record
Waterfall[1]	**FALL**	Distance, estimated height
Tributary	**TRIB**	Distance, average wetted width, into main channel on left or right (as facing upstream)
Side channel[2]	**SCH**	Distance, average wetted width, whether it is flowing into or out of main channel on left or right (as facing upstream)
Braid[3]	**BRD**	Distance at start and distance at end; continue with normal inventory up channel with greatest discharge
Seep (Spring)	**SEEP**	Distance, left or right bank (as facing upstream), size, coloration
Landslide	**SLID**	Distance, left or right bank (as facing upstream), estimated size
Other	**OTR**	Distance, description of feature, *example:* found water intake pipe going to house here; old burned out shack on side of stream; Big Gap campground on left; alligator slide here, etc.

1 must be vertical with water falling through air to be a waterfall and not a cascade, do not record unless >1m high
2 two channels, continue with normal inventory up channel with most volume
3 three or more channels intertwined, continue with normal inventory up channel with most volume

Crossing Feature	Abbreviation	What to Record*
Bridge	**BRG**	Distance, width, height, road or trail name and type (gravel, paved, dirt, horse, ATV, etc.), photo
Ford	**FORD**	Distance, road or trail name and type (gravel, paved, dirt, etc.), photo
Dam	**DAM**	Distance, type, condition, estimated height, dam use, name of road or trail, if applicable; include beaver dams, photo
Culvert	**V**	Distance, road or trail name, type, # of outlets, diameter/width, height, material, perch (distance from top of water to bottom lip of culvert, natural substrate (present or absent through length), photo

* photograph all crossing features with person and wading rod for scale, record 'Y' in 'Photo' column

We cannot stress enough the importance of fully and accurately describing features. This means getting out a quadrangle map and finding road, trail, and tributary names and recording them in 'Comments' and taking the time to describe the location of features in relation to landmarks found on quadrangle maps.

Take photos of all crossing features!

Section 3: Wrapping Up

End the inventory where:

- Forest Service property ends
- stream is dry for more than 1000 m
- stream channel is < 1.0 m wide for more than 500 m

Record the following in the Comments:

- Time and date
- Reason for ending the inventory
- Detailed written description of location using landmarks for reference

** be sure the header information is completed – GPS, etc.**

When you return to home base:

- Immediately download the data and check file to be sure all data downloaded
- Check header information to be sure it is complete
- Note in all files if more than one file was used during the inventory
- Save to the computer and create a backup copy
- Document any photographs
- If using paper, make a photocopy of the data and store in secure location
- Record on master list that inventory is complete, with data and names of crewmembers

Section 4: Summary

Before starting, determine interval, select random number, fill in header information

Record for every habitat unit:

- Unit Type
- Unit Number
- Distance
- Estimated Width
- Maximum Depth
- Average Depth
- Dominant Substrate
- Subdominant Substrate
- Rosgen Channel Type
- Percent Fines
- Large Wood

Record for every riffle, run, or cascade leading into a pool or glide:

- Riffle Crest Depth

Record for every paired sample pool:

- Measured Width

Record for every paired sample riffle:

- Measured Width
- Channel Width
- Riparian Width (left and right)
- Gradient
- Water temperature
- Photograph

Record features and full feature descriptions wherever they are encountered. Photograph all crossings!

When end of inventory is reached, record reason for ending, date, and time, be sure data is saved in safe location, and record inventory start and end points on master maps.

Section 5: Field Guide, Random Numbers Table, Equipment Checklist

Record for every habitat unit:

Unit Type: pool, riffle, run, cascade, glide, feature (see below)
Unit Number: group pools & glides; group riffles, runs, cascades
Distance: (m) at upstream end of unit
Estimated Width: (m) visual estimate of average wetted width
Maximum Depth: (cm) deepest spot in unit
Average Depth: (cm) average depth of unit
Dominant Substrate: (1-9) covers greatest amount of surface area in unit
Subdominant Substrate: (1-9) covers 2nd most surface area in unit
Rosgen Channel Type: (A-G) see table of channel characteristics below or refer to Rosgen book
Percent Fines: (%) percent of bottom consisting of sand, silt, or clay
Large Wood: (1-4, RW) count of dead and down wood in the bankfull channel

Record for every riffle, run, or cascade leading into a pool or glide:

Riffle Crest Depth: (cm) deepest spot in hydraulic control between riffle type habitat and pool type habitat

Record for paired sample pools:

Measured Width: (m) measurement of average wetted width

Record for paired sample riffles:

Measured Width: (m) measurement of average wetted width
Channel Width: (m) measurement of bankfull channel width
Riparian Width: (L&R) (m) measurement of floodplain
Gradient: (%) clinometer measurement of riffle slope
Water Temperature: (C) temperature of water in Celsius
Photo (y or n): picture of habitat unit or crossing feature

Unit Types

Riffle (R) fast water, turbulent, gradient <12%; includes rapids, chutes, and sheets if gradient <12%
Cascade (C) fast water, turbulent, gradient ≥12%, includes sheets and chutes if gradient ≥12%
Run (RN) fast water, little to no turbulence, gradient <12%, flat bottom profile, deeper than riffles
Pool (P) slow water, may or may not be turbulent, gradient <1%, includes dammed, scour, and plunge pools
Glide (G) slow water, no surface turbulence, gradient <1%, shallow with little flow and flat bottom profile
Underground (UNGR) distance at upstream end, why dry

Features – don't forget to photograph!

Waterfall (FALL) distance, height
Tributary (TRIB) distance, width, in on L or R
Side Channel (SCH) distance, width, in or out on L or R
Braid (BRD) distance at downstream and upstream ends
Seep or Spring (SEEP) distance, on left or right, amount of flow
Landslide (SLID) distance, L or R, est. size and cause
Other (OTR) record distance, describe feature in comments
Crossing Features: Photograph and record the following:
Bridge (BRG) distance, height, width, road or trail name & type
Dam (DAM) distance, type, est. height, road or trail name &type
Ford (FORD) distance, road or trail name & type
Culvert (V) distance, type (pipe, box, open box, arch, open arch), size, material, natural substrate, perch (top of water to culvert) road or trail name

Substrates

1. **Organic Matter**, dead leaves detritus, etc., not living plants
2. **Clay**, sticky, holds form when balled
3. **Silt**, slick, does not hold form when balled
4. **Sand**, >silt-2mm, gritty, doesn't hold form
5. **Small Gravel**,3-16mm, sand to thumbnail
6. **Large Gravel**, 17-64mm, thumbnail to fist
7. **Cobble**, 65-256mm, fist to head
8. **Boulder**, >256, > head
9. **Bedrock**, solid parent material

Large Wood

1. <5m long, 10-55cm diameter
2. <5m long, >55cm diameter
3. >5m long, 10-55cm diameter
4. >5m long, >55cm diameter

RW: rootwad – count separately from attached LW, record in comments, do not record wood <10cm diameter, <1m length

Rosgen Channel Types	A	B	C	D	E	F	G
Entrenchment	< 1.4	1.4 – 2.2	> 2.2	n/a	> 2.2	< 1.4	< 1.4
W/D Ratio	< 12	> 12	> 12	> 40	< 12	> 12	< 12
Slope (%)	4 – 9.9	2 – 3.9	< 2	< 4	< 2	< 2	2 – 3.9

Measuring Riparian Width (n^{th} riffle, run, cascade only)
Place clinometer against the wading rod at two times max bankfull depth
Use the clinometer as a level – keep the slope at 0.0 – and site to the nearest landform perpendicular to the channel
Measure the distance from the edge of the bankfull channel to the intersection with the landform
Do this for both the left and right banks
If riparian width in more than 50 m, record 51 as the riparian width and in 'Comments' note that riparian was > 50 m wide

End inventory
Where stream is less than 1.0 m wide for > 500 m, or channel runs dry for > 1.0 km, or where boundary is reached. Comment on why inventory was ended. Record time of day, detailed description of location, and GPS coordinates at endpoint, and be sure all header info is filled in on datasheets.

Random numbers for measuring every 5^{th} unit

4	3	5	1	5	1	2	5	2	3
2	5	2	5	2	2	1	5	4	1
3	2	5	1	2	1	3	1	5	3
5	4	1	5	1	3	5	4	2	5
4	2	2	5	2	2	5	5	2	1
4	2	5	2	2	4	5	5	5	2
3	5	4	1	5	1	4	1	3	3
1	4	2	2	1	4	3	1	5	3
5	4	3	3	2	4	1	2	5	1
4	4	1	1	3	5	1	5	5	4

Random numbers for measuring every 10^{th} unit

3	7	10	5	1	2	2	7	10	6
4	2	3	8	9	2	4	4	6	9
3	3	8	4	3	9	9	7	5	5
1	3	5	5	2	6	5	2	2	6
3	7	8	6	3	8	8	5	2	10
10	9	6	9	4	3	10	7	2	10
6	10	5	4	8	10	4	1	4	10
4	3	4	3	2	3	4	4	3	7
5	1	7	9	7	3	10	7	10	3
9	6	8	6	2	2	1	9	10	5

Choose a new random number at the beginning of each stream inventory
Use the number for the entire stream
Use the first table for streams < 1.0 km long, the second table for streams >1.0 km long

Equipment Checklist

hipchain
extra string for hipchain
wading rod
50 m tape measure
clinometer
thermometer
datalogger
backup battery for datalogger
GPS unit
camera
backpack
pencils
flagging
markers
waterproof backup datasheets
clipboard
BVET manual
BVET field guide on waterproof paper
topographic maps
water
water filter
lunch
first aid kit
hardhats
high-viz vests
radio/cell phone
toilet paper
felt bottom wading boots
raingear

Remember the following for the start of each new stream or reach:

- Determine measuring interval
- Select a random number
- Fill in header information completely